EBnet

EBnet Status Briefing

August 31, 1995

EBnet

Agenda

1.	Introduction	Hal Folts
2.	Requirements Sources	Dick desJardins
3.	EBnet Overview	Steve Smith
4.	EBnet Requirements	Steve Smith
5.	EBnet Architecture and Implementation	Chris Garman
6.	Wrap-Up	Steve Smith/Hal Folts

Introduction

- Purpose
  - Overview of the Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet)
- Scope
  - Focus on high-level system requirements, roles and responsibilities
  - Management and technical approaches to implementation

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History

- EOS Communications (Ecom) to support transport of real-time command, control, telemetry, and raw science data
- EOS Science Network (ESN) under EOS Core System (ECS) contract to provide transport of high-level processed science data products between Distributed Active Archive Centers (DAACs)
  - Prototype V0 Network fielded and intended as baseline
- Network Backbone Team organized in March 1995 to explore consolidated Wide Area Network (WAN) initiative:
  - Nodal commonality among Ecom and ESN sites
  - Ecom and ESN were both router based
- Alternative configurations were studied with consideration given to benefits and disadvantages of each option

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History (Cont'd)

- May 23, 1995, Decision Memorandum issued by Dale Harris formally announced the networks consolidation:
  - Nascom Division assigned responsibility for development, implementation, and operation of network to support data flows between the EOS Data and Operations System (EDOS) Data Processing Facility and DAACs, and between DAACs
  - Development and implementation of EBnet falls under Earth Science Data and Information System (ESDIS) Project Management purview of the ESDIS Distributed Systems and Networks Office (DSNO) Manager
- EBnet Team representing Codes 505, 520, 540, and contractor staff was formed to develop plan for transitioning maintenance and operations of V0 Network to Nascom

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Requirements Sources

R. desJardins

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Requirements Overview

- EBnet requirements are of two types:
  - Project and System requirements
    - Programmatic requirements
    - Overall System requirements
    - Functional and performance requirements
  - Internal Networks Traffic requirements
    - Data flows of all EOSDIS missions

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System and Project Requirements

- Documented in ESDIS Level 2, EBnet Requirements Document (Volume X)
  - Companion document to ESDIS Level 2 Requirements, Volume 0: Overall ESDIS Project Requirements
  - Review version available
- Following source documents were utilized to generate the ESDIS Level 2, Volume X Requirements Document :
  - Level 1, EOS Requirements (Execution Phase Project Plan for EOS)
  - Level 2, Volume 0: General ESDIS Project Requirements
  - Level 2, Volume 1: ECS Requirements
  - Level 2, Volume 2: EDOS and Ecom Requirements
  - Communications Requirements for the ECS Project (Data Item Description [DID]-220)

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Internal Networks Traffic Requirements

- EBnet project will manage the Internal Networks Traffic Requirements utilizing a database containing:
  - Raw traffic requirements
  - Traffic model
  - Burdened traffic requirements
- All ECS raw traffic requirements will be documented in DID 220
- Traffic summary reports and status information will be available to ESDIS on request

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EBnet Overview

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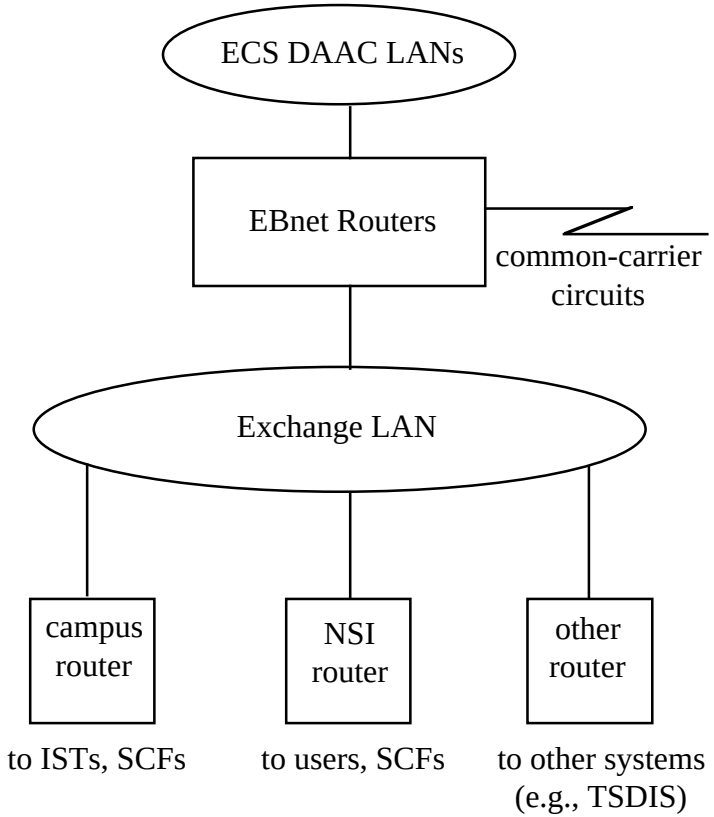
EBnet Overview

- EBnet will consist of a single, consolidated network which provides connectivity between ECS DAACs, EDOS, selected Affiliated Data Centers (ADCs), and other designated EOSDIS sites
- Instrument Support Terminals (ISTs), formerly connected to the DAAC-to-DAAC network, will be provided connectivity via the NASA Science Internet (NSI)



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EBnet Development Organization

Office of Mission Operations &
Data Systems for ESDIS, Code 505
Dale Harris, Associate Director
Mel Banks, Chief Development Office

Distributed Systems & Networks
Organization, Code 505
Hal Folts, DSNO Manager

Assurance Management
Office, Code 303
Bob Calvo, QA Manager

NASA Communications
Division, Code 540
Steve Smith, Project Manager

EBnet Project
Organization, Code 540
Chris Garman, System Engineer

Version 0 Transition
Team, Code 540
Mary Douglas, Lead

Requirements Analysis
Team, Code 540
Chris Garman, Lead

Design Team,
Code 540
Mary Douglas, Lead

EBnet Implementation
Team, Code 540
Mary Douglas, Lead

Test Team,
Code 540
To Be Named

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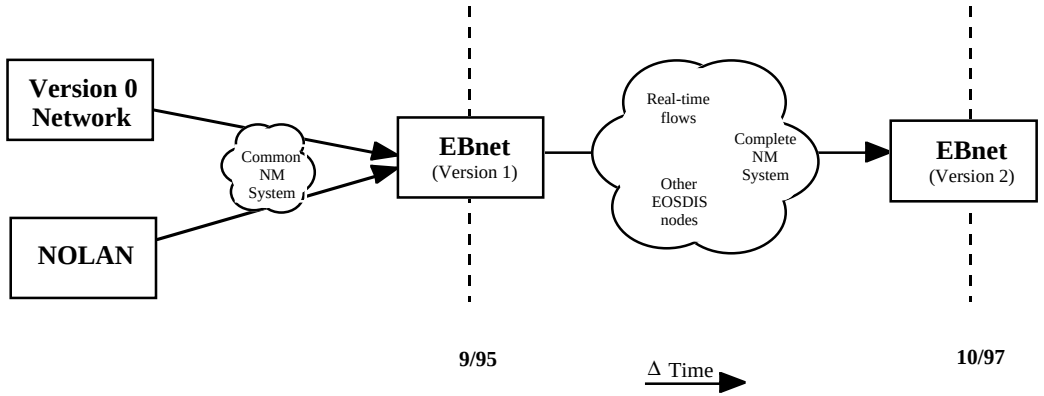
Project Replan

- Consolidation of V0, NOLAN, ESN WAN, and Ecom resources
  - EBnet technical team structures to take advantage of past experience
    - Code 540
    - ECS/HAIS
    - Hughes/STX
    - SEAS
    - NMOS
  - Implementation approach utilizes existing networks as the building blocks for EBnet



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Roles And Responsibilities

- In-house team will lead development and implementation:
  - Oversight by DSNO Project Manager from Code 505
  - EBnet Project Manager, System Engineer, and other support staff from Code 540
  - Quality Assurance Manager from Code 303
- Multiple contract vehicles exercised to optimize synergetic skill mix:
  - Design and implementation of V0 network led by AlliedSignal Technical Services Corporation (ATSC) under the Network Mission Operations Support (NMOS) contract; assisted by Version 0 (V0) transition team contractors from SEAS (Loral Aerosys), RMS, and Hughes STX (HSTX)
  - System design and implementation of integrated networks (i.e., V0, Nascom Operational Local Area Network [NOLAN], and EBnet) collaborative effort by V0 Transition Team contractors plus Systems, Engineering, and Analysis Support (SEAS) contractors, Computer Sciences Corporation (CSC), and Loral Aerosys

Roles And Responsibilities (Cont'd)

- Network Management System development for V0 through EBnet led by HSTX, via tasking through Code 900 contract
- Interface development, facilities planning, data flow and requirements management, and Exchange LAN design support provided by Hughes Applied Information Systems (HAIS) under the ECS contract
- Project management and test support provided by Booz•Allen & Hamilton (BA&H) under the NMOS contract
- Maintenance and Operations provided by ATSC and RMS under the NMOS contract

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Project Tool Set

- Use of a full complement of tools to schedule and track Project performance
  - Project Evaluation and Review Technique (PERT)/Critical Path Method (CPM) analyses
  - Master and Detailed Milestone schedules
  - Automated cost projection and analysis tool
- Risk Mitigation emphasized through up-front analysis of industry status and early identification of risk areas through EBnet Modeling, Analysis, and Testbed (EMAT) activities
  - Perform trade-off and compatibility analyses
  - Verify Commercial off-the-shelf (COTS) performance measures
  - Identify candidate hardware and software
  - Test candidate configuration scenarios

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EBnet Requirements

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Requirements Categories

- EBnet requirements are categorized into the following types:
  - Programmatic
  - Overall System
    - General
    - Integration and Test
    - Prelaunch Support
    - Reliability, Maintainability, Availability (RMA)
    - System Access
    - Security
    - End-to-End Fault Management
  - EBnet Functions
    - Mission Operations
    - Data Distribution
    - Communications and Networking
  - Interfaces

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Recent Programmatic Changes Impacting Requirements

- Programmatic deltas
  - Overall data rate requirements for EOS have decreased from initial projections
  - EOS Level 1 requirements scrub has resulted in science product data availability and performance figures equivalent to DAAC to DAAC data transfer rates from .9998 to .98
  - Mean Time To Restore Service (MTTRS) for science data relaxed from 15 minutes to 4 hours
  - EDOS consolidation at WSC
  - Decoupling of EDOS and EBnet (Ecom) requirements; EBnet network management interface moved to System Management Center (SMC)
  - Use of subsetting for AM-1 and future missions

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Consolidation and Technology Related Changes Impacting Requirements

- Consolidation of Wide Area Communications has resulted in a shift of requirements to EBnet
  - DAAC to DAAC and ADC requirements flows
  - Mission support role for TRMM, Landsat 7
  - Responsibility for Version 0 operations, maintenance, and engineering
  - Campus/Exchange Local Area Network (LAN) design and implementation
- Technology deltas
  - Router performance has demonstrably improved in the last year from 18 Mbps to 43 Mbps and improving
  - ATM technology maturation slower than expected
  - Availability of COTS packages for network management related functions

Requirements Management Approach

- Working with DSNO to develop documentation hierarchy and approach to requirements management
  - Requirements management philosophy based on reducing documentation to a bare minimum while maintaining the integrity of the Project. Significant reduction appropriate now:
    - EBnet will be based on existing networks (e.g., NOLAN, V0)
    - COTS intensive implementation
    - Router-based network implementation well understood

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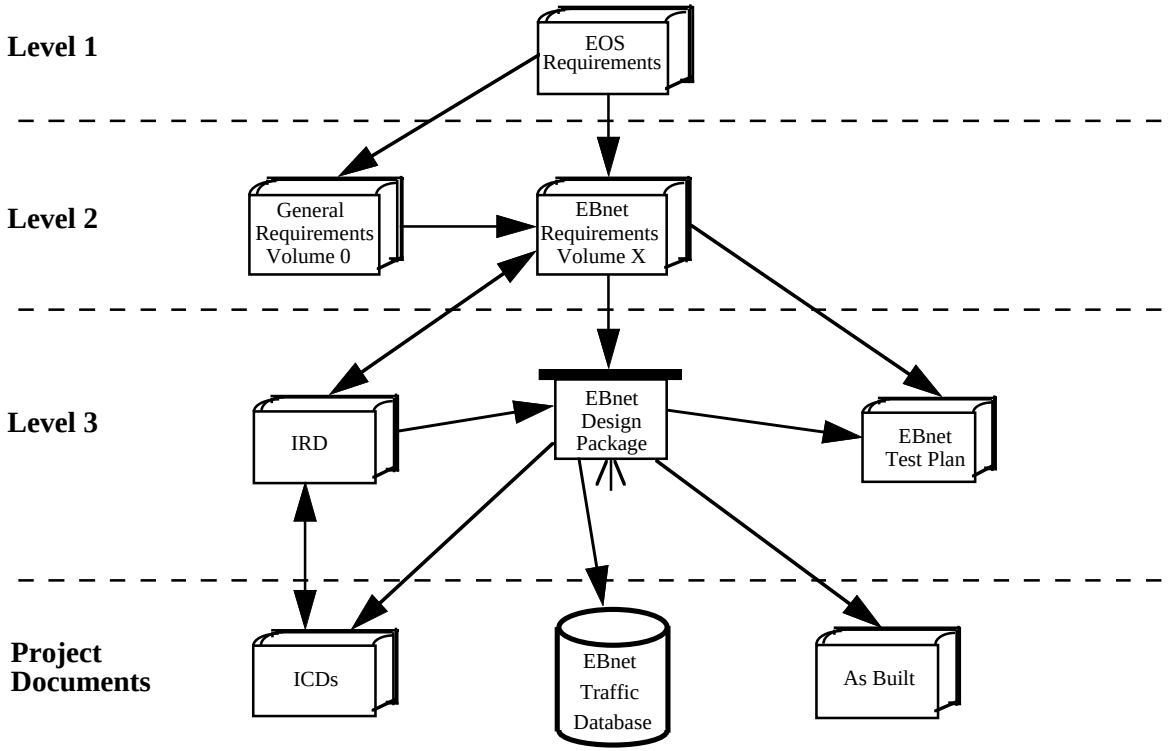
Documentation Hierarchy with Traceability

- Requirements and Traceability Management (RTM) tool will be utilized to ensure traceability throughout the Project
  - Developed documentation tree showing requirements traceability from Level 1 EOS Requirements to as-built network



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Traceability Findings

- Level 2, Volume 0, requirements document not being applied consistently across other volumes of the ESDIS Level 2 requirements document
  - In some cases Volume 0 is reference, and in other cases it is not
- Programmatic requirements interspersed with system requirements; some of these requirements are untestable
- Opened-ended, untestable requirements
- Duplicate system requirements
- Restrictive design requirements that impact a COTS based architecture solution

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Traceability Findings (Cont'd)

- Inconsistent requirement format among Level 2 documents
- Requirements statements which actually contain a series of requirements (compound requirements)
  - Requirements must be normalized before traceability can occur
  - Increases complexity in verifying requirements through testing

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Overall Documentation Summary

Operational Readiness Review

- Station Handbook
- As-Built Documents and Design Description

Status Briefing

- Level 2 Requirements Document
- Interface Requirements Document

External Test Readiness Review

- Test Report

Design Review

- Design Package
- System Test Plan
- System Implementation Plan
- Interface Control Documents
- Operations Concept Document

Documents not specific to a review

- Site Installation Checkout Plans and Procedures
- EMAT Reports
- Training Course Materials and Evaluations

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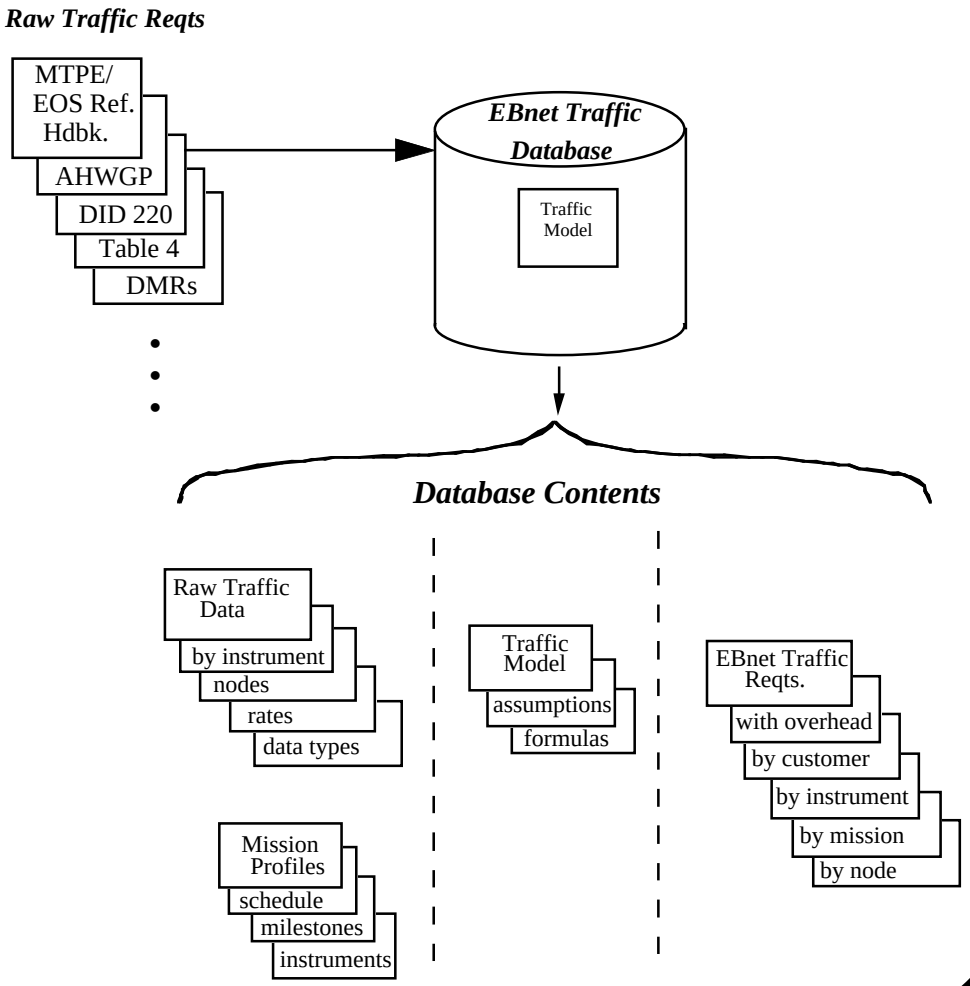
Requirements Management Approach (Cont'd)

- Created Traffic Requirements Database to track evolving data flow projections
- Nascom developed traffic database will contain all Internal Networks Traffic



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Requirements Wrap Up

- Requirements analysis on going
- Working with ESDIS project to resolve open issues
  - Participant in Networks Telecons (NTs)
  - Supporting ESDIS Requirements Management activities

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Architecture and Implementation

C. Garman

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EOSDIS Context Drawing

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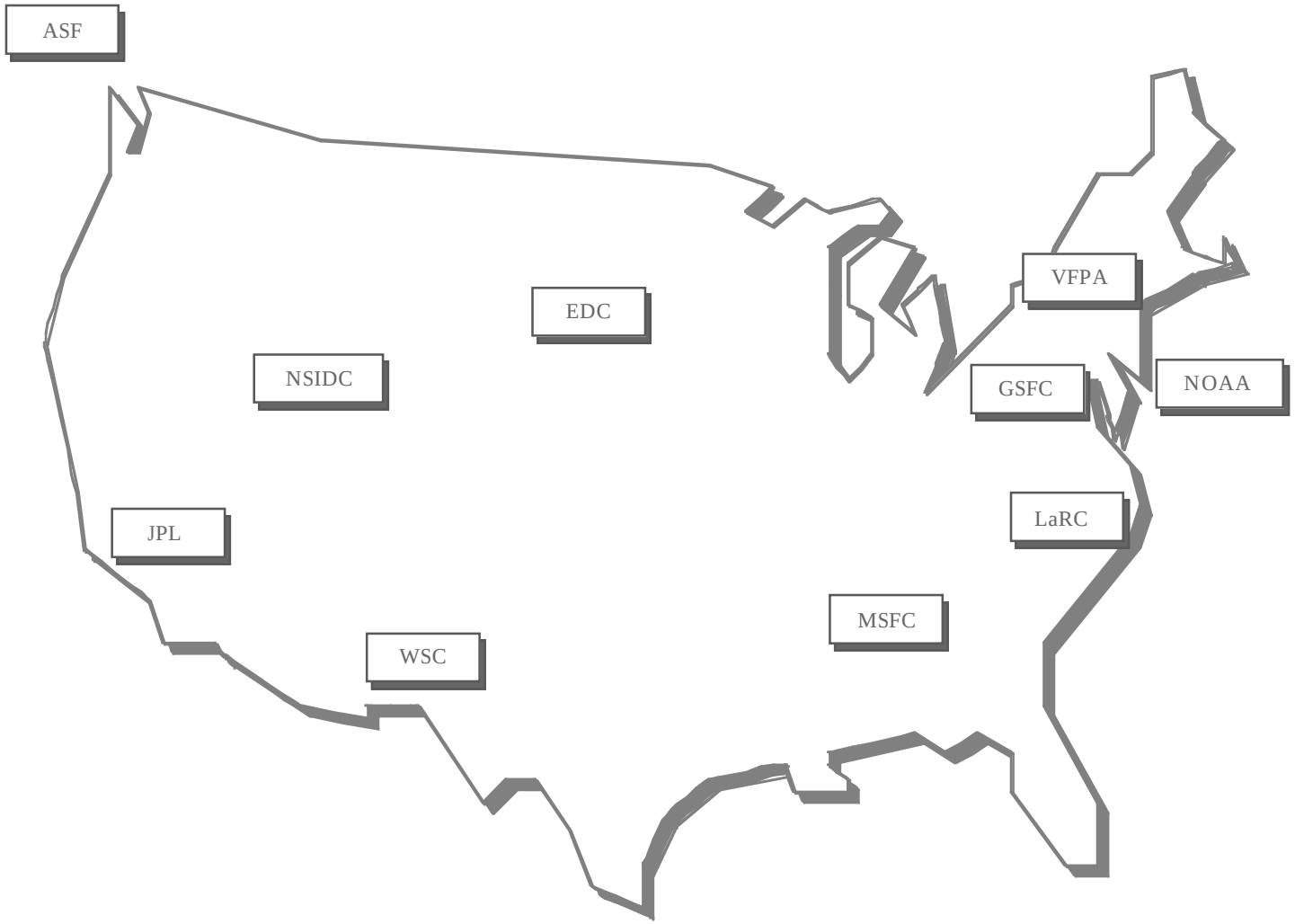
EBnet Nodes



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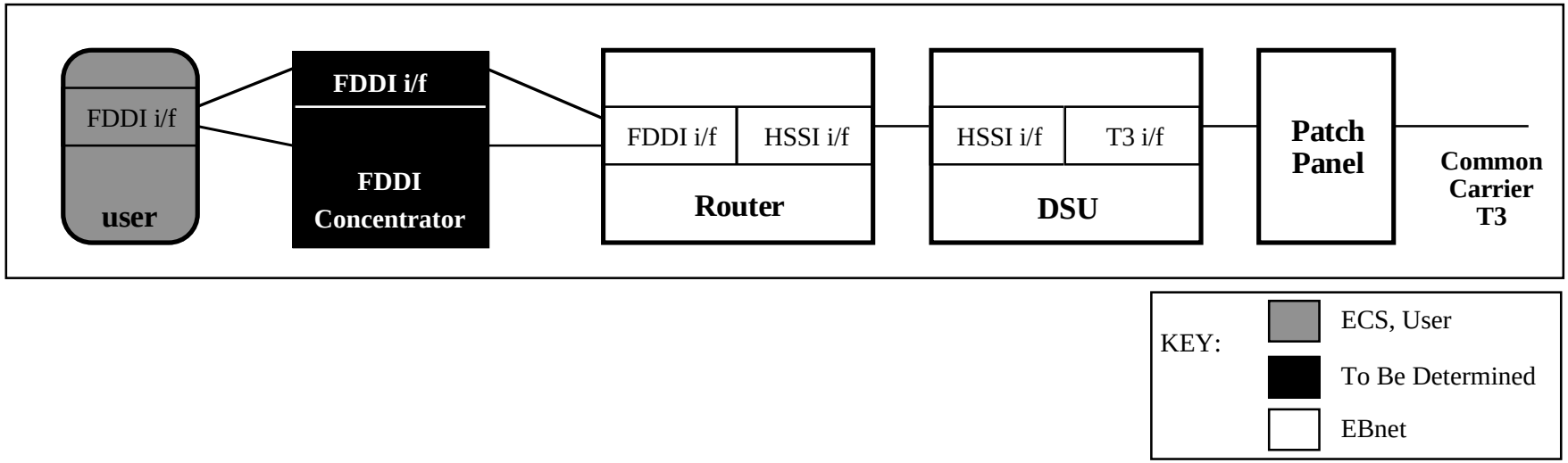
Candidate Science Node Configuration



- Redundant equipment not required
  - MTTRS = 4 hours
  - Availability = 0.98
  - Users can dual-home to two cards in one concentrator
- Demarcation between EBnet and ECS will be finalized during the ICD negotiation

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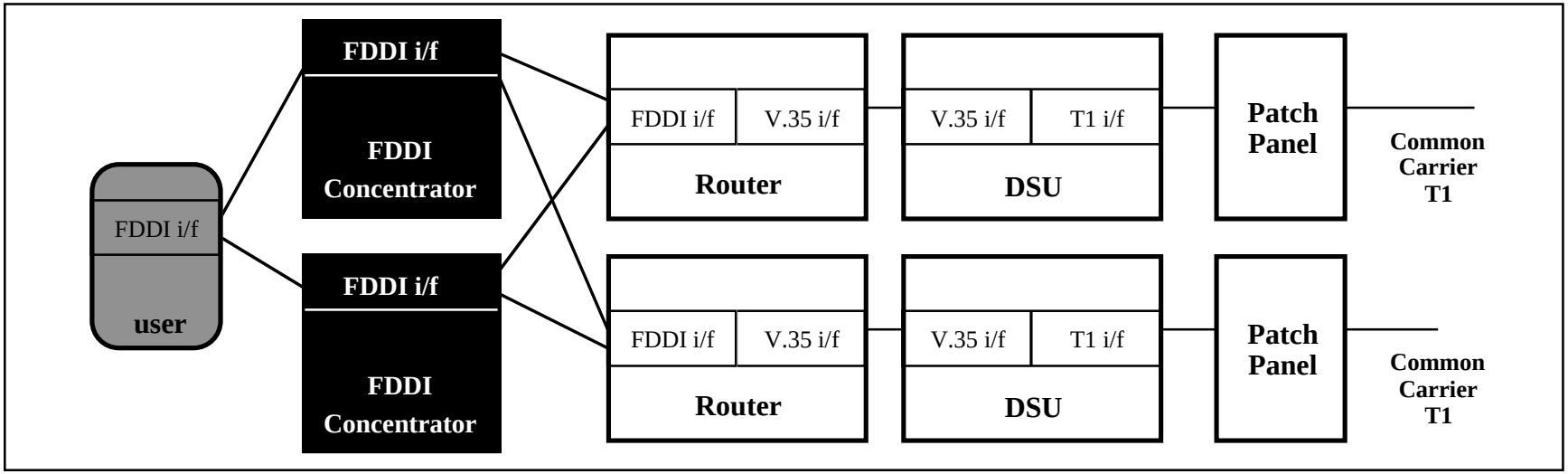
Candidate Real Time Node Configuration



- Redundant equipment is required
  - MTTRS = 1 minute
  - Availability = 0.9998
  - Users can dual-home to two concentrators
- Demarcation between EBnet and ECS will be finalized during the ICD negotiation

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System Implementation

- EBnet implementation planned in phases
  - Transition of Version 0 Network (September 1995)
  - Integration of Version 0 Network and NOLAN to support Tropical Rainfall Measuring Mission (TRMM) testing (December 1995)
  - Network build out to full EBnet capability
    - TRMM operational support (November 1996)
    - Landsat 7 testing and operational support (January 1997)
    - AM-1 testing and operational support (January 1997)

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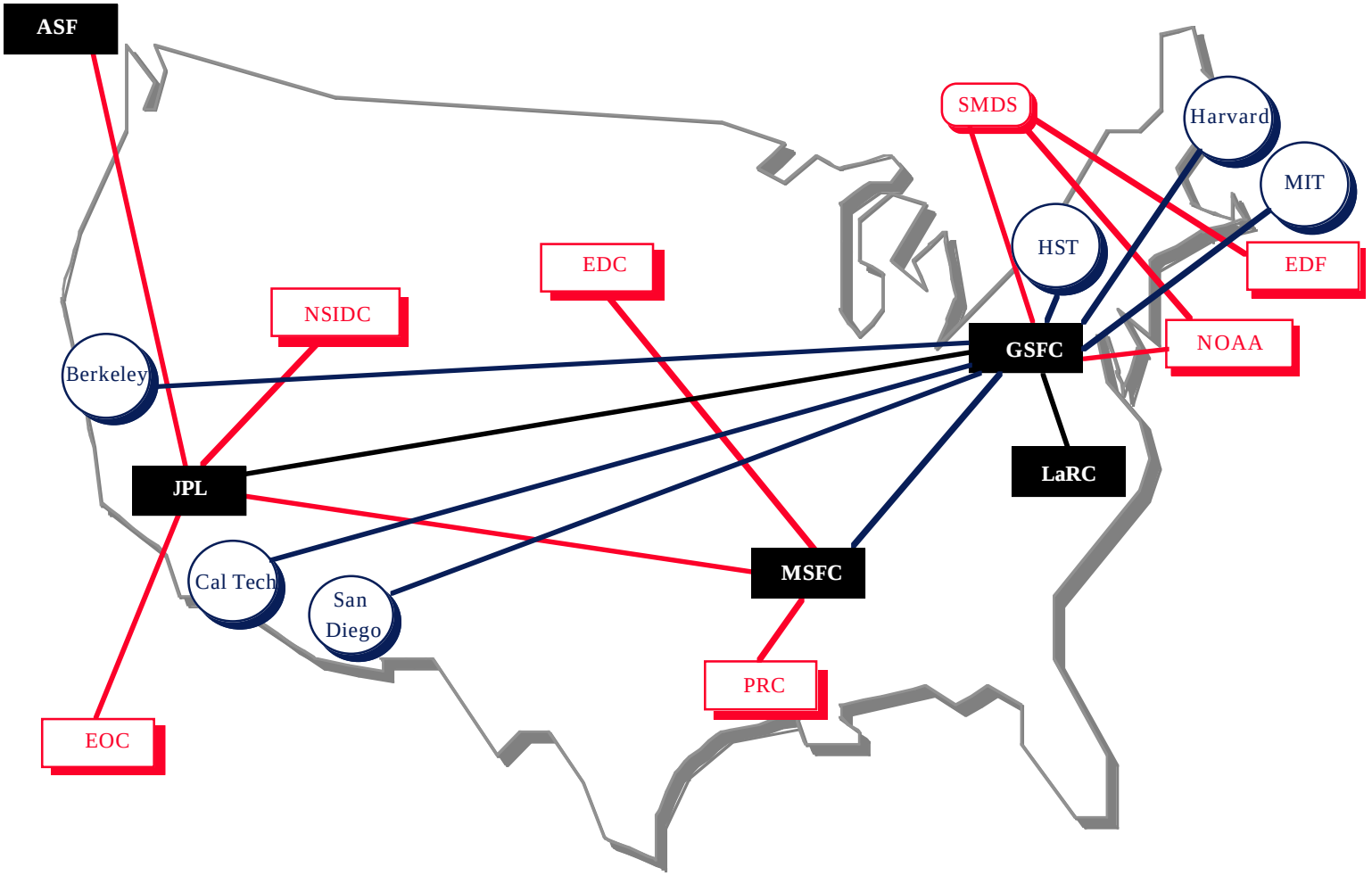
Version 0 and NOLAN (Planned) Networks



V0 Node

Node V0 and NOLAN Node

NOLAN Node

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Version 0 Network Transition Approach

- Transition Team created to plan and execute transition of Version 0 network from Code 520 to Code 540
  - Transition Team chaired by Hal Folts/DSNO Manager
  - Transition Team consisted of DSNO manager, DSNO System Engineer, EBnet Project Manager, EBnet System Engineer, ECS, EBnet Maintenance and Operations Support Contractor (NMOS)
- Transition approach planned in four phases
  - Familiarization and Orientation
  - Configuration, Documentation, and Training
  - Shadow Management and Outreach
  - Turnover
- Transition Plan developed and distributed on 6/30/95 under cover letter of DSNO manager

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Version 0 Network Transition Status

- EBnet team, working directly with VO Network Engineer, has completed most transition activities
  - Transition team familiar with overall network implementation, specific node implementations, and overall network operations
  - Validation of hardware configurations complete
  - EBnet responsible for network monitoring with V0 System Engineer performing shadow management
- Activities required to finalize the V0 Network Transition
  - Turnover expected within the next month
  - Customer outreach
    - DAAC visits being planned for the beginning of next fiscal year
    - Outreach presentation being developed to discuss transition status and future implementations and enhancements

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VO and NOLAN Integration Approach

- Nodes supported jointly by NOLAN and V0 (planned or in place) are being merged into one point-of-presence
  - Specific nodes: Jet Propulsion Laboratory (JPL), Alaska Synthetic Aperture Radar Facility (ASF), Marshall Spaceflight Center (MSFC), LaRC, GSFC
  - Upgrades in progress to support TRMM testing
    - Hardware upgrades to Cisco routers ordered for MSFC and LaRC
    - Circuit upgrade planned for LaRC-GSFC data flow through Nascom 2000 procurement vehicle to support TRMM Mission Operations Center (MOC)-IST interface
- NOLAN and V0 Network Management integration in place
  - Implemented in Hewlett Packard (HP) Openview COTS package
  - Currently managing NOLAN and V0 nodes

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Build Out to Full EBnet Capability

- Building off the integrated V0 and NOLAN Networks, EBnet will use a three-phase implementation approach
  - Requirements Analysis
  - Design and Implementation
  - Test

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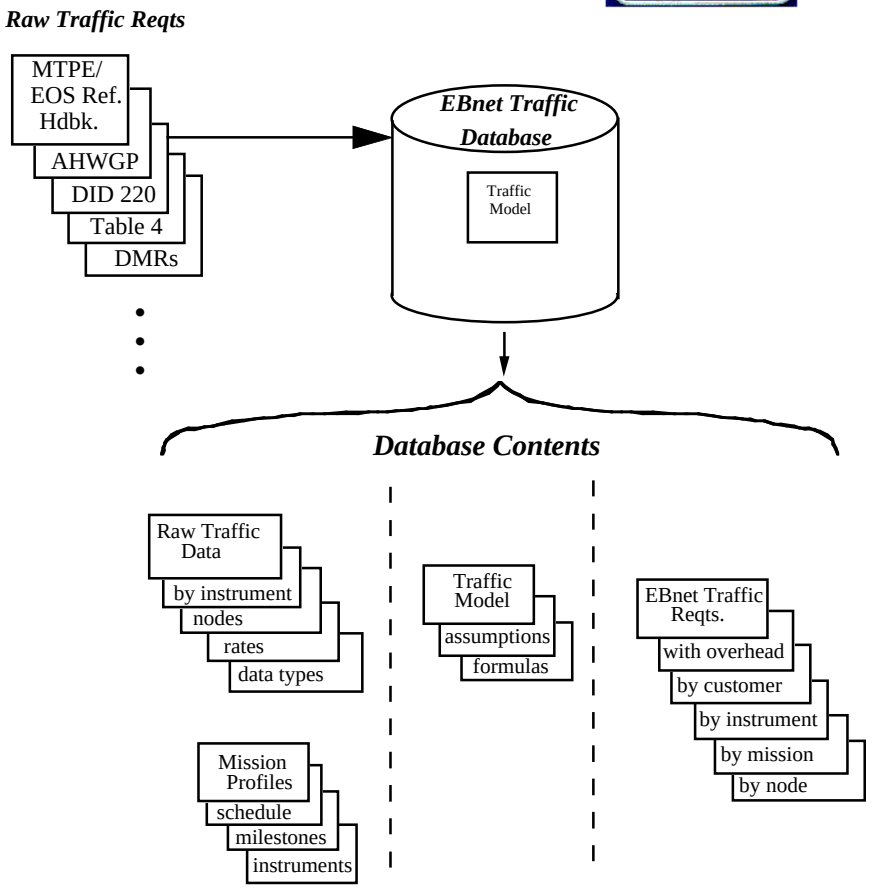
Requirements Analysis Phase

- EBnet Traffic Database will contain all Internal Networks Traffic
  - Raw traffic requirements will be obtained from various sources
  - A traffic model will be designed and implemented within the database to apply overhead factors to raw data requirements
  - Burdened traffic requirements will be output from the database



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Design and Implementation Phase

- Optimized topologies will be developed for the real-time and science networks
  - Combined manual and automated design effort will be performed using the Windows-Modular Interactive Network Design (WIN-MIND) Modeling Tool
  - An independent effort will be performed to validate the topology
- Continue market surveys for more advanced, emerging modeling tools

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Design and Implementation Phase (Cont'd)

- Node and interface design is being performed by the core EBnet design and implementation team
  - Design will be led by Code 540 Government engineers with technical support from contractors
  - Representatives from other organizations (e.g., ECS, NSI) will support the design process
  - Technical team recently formed to focus on network interfaces
    - Representative(s) from this team will support the design process
    - Interfaces will be designed in conjunction with technical representatives from interfacing organizations
    - EBnet project will lead development of individual Interface Control Documents (ICDs) with each interfacing organization
  - Work directly with campus representatives to design node unique campus LAN connectivity

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Design and Implementation Phase (Cont'd)

- Bill of Materials will be generated from the node designs and topologies
- Hardware and software will be integrated at the SEAS development facility
- After integration and check-out equipment will be shipped to individual nodes for installation

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Test Phase

- EBnet Project Internal Testing
  - Node testing performed at development facility for each node added to the network
    - Checkout of each piece of equipment
    - Validate functionality of nodes/networks
  - Add new circuit capacity “just in time” to support testing and operational requirements
  - Complete functional testing prior to external need date for TRMM testing (1/96)
  - Regression testing of configuration changes as they are implemented

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Test Phase (Cont'd)

- EBnet Project Internal Testing
  - System/Acceptance Testing conducted in the field
    - Perform node testing for all nodes
    - Full network stress testing with user participation
    - Complete System/Acceptance Testing prior to external need date for AM-1 testing (1/97)
- External Testing
  - EBnet project will support all planned ESDIS tests
    - EBnet project will meet currently advertised test dates
    - Prior to each external test, the network will be frozen by EBnet project

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Wrap Up

S. Smith/H. Folts

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Schedule Considerations

- EBnet Team is committed to meeting all EOSDIS need dates
- Current schedule drivers:
  - TRMM test support January 1996
  - AM-1 test support January 1997
- Near-term milestones:
  - Completion of Version 0 Network transition (September 1995)
  - Node and circuit enhancements required to support TRMM testing (September/October 1995)
  - Internal testing to assess readiness to support TRMM testing (November 1995)
  - EBnet Design Review (November 8, 1995)
- Preliminary PERT analysis shows:
  - One month positive slack for supporting TRMM testing
  - Four months positive slack for supporting AM-1 testing

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Project Master Schedule

Phase/Mileston	1995	1996	1997	1998	1999
Launch Milestones		△ ADEOS	△ TRMM	△ LANDSAT 7 △ AM-1	
ECS Milestones	▲ CDR	△ IR-1	△ Rel. A	△ Rel. B	
EBnet Reviews	△ Status Briefing	△ Design Review △ TRMM Test Readiness Review	△ L7/AM-1 Test Readiness Review		
EBnet Implementation	△ Order Equipment	△▽ Equipment Integration and Checkout △▽ Site Installation	△▽ System Acceptance Test △▽ Incremental Turn-up of Circuits		
TRMM Implementation & Testing Support (V0 and NOLAN Buildout)	▲▽ V0 Network Transition	△▽ Node/Circuit Upgrades (V0 and NOLAN) △▽ Handoff Testing △ Science Data Processing Test #3	△ Mission Simulation #1 △ Mission Simulation #2		
Landsat 7 Testing Support				△ ETE #1 △ ETE #2 △ ETE #3	
AM-1 Testing Support		△ EOC Compatibility Test #1 △ EOC Compatibility Test #3	△ EOC Compatibility Test #2	△ ETE Test	

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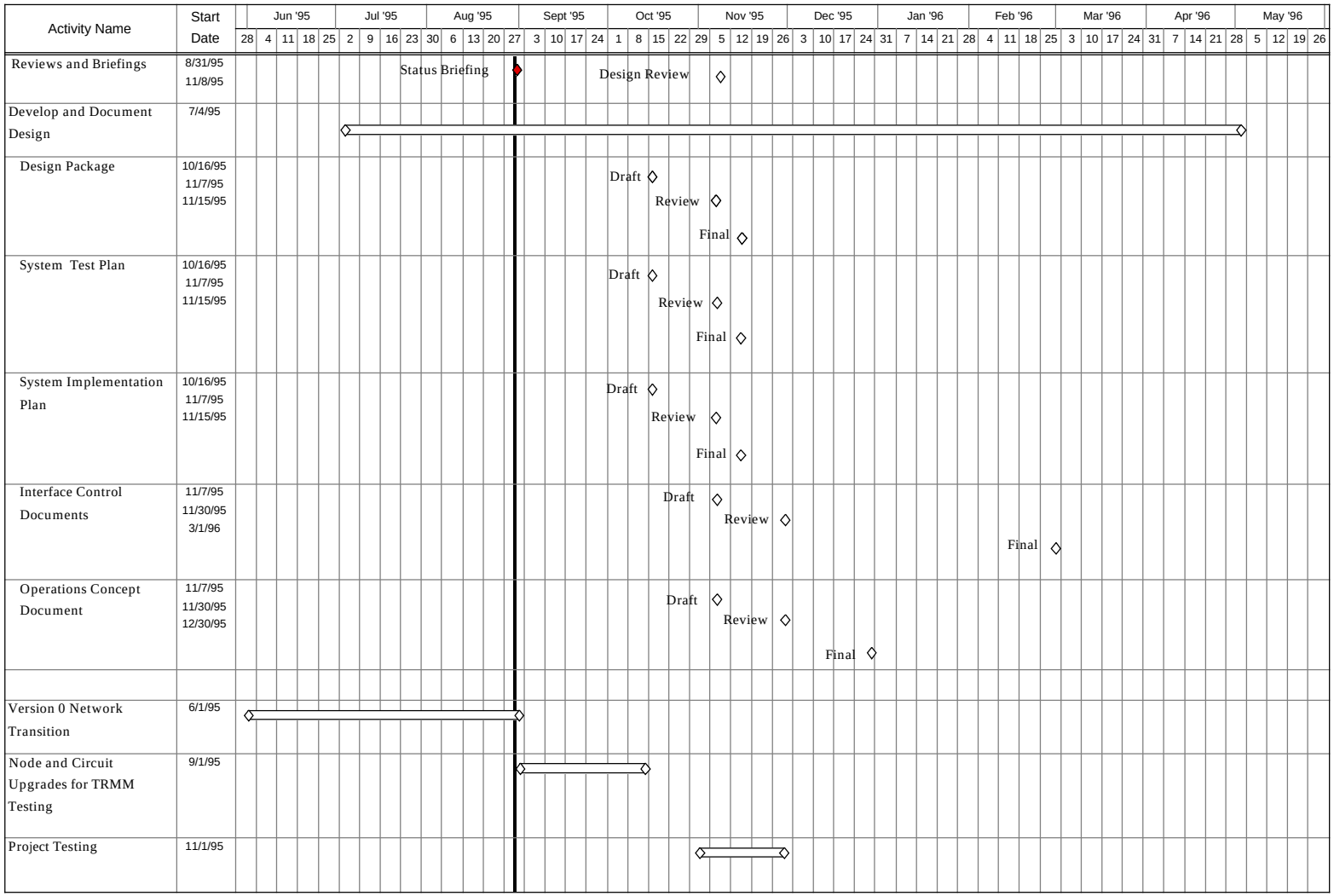
Road to Design Review

Activity Name	Start Date
Reviews and Briefings	8/31/95 11/8/95
Develop and Document Design	7/4/95
Design Package	10/16/95 11/7/95 11/15/95
System Test Plan	10/16/95 11/7/95 11/15/95
System Implementation Plan	10/16/95 11/7/95 11/15/95
Interface Control Documents	11/7/95 11/30/95 3/1/96
Operations Concept Document	11/7/95 11/30/95 12/30/95
Version 0 Network Transition	6/1/95
Node and Circuit Upgrades for TRMM Testing	9/1/95
Project Testing	11/1/95



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Cost Considerations

- EBnet costs were rebaselined during the July 1995 time frame to reflect consolidation and requirements changes
- Costs changed in the following areas:
  - Manpower
  - Equipment
  - Circuits
  - Maintenance and Operations
  - Grand total

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Assumptions

- Worked with DSNO to establish baseline set of assumptions:
  - EBnet shall build on the V0 network, and other existing capabilities whenever cost effective
  - Data processing function to be performed by EDOS at the White Sands Complex (WSC) rather than at the Data Processing Facility (DPF) at Fairmont, West Virginia
  - Subsetting introduced for the Goddard Space Flight Center (GSFC)-to-EROS Data Center (EDC) and GSFC-to-Langley Research Center (LaRC) production data flows
  - Science traffic and real-time traffic supported via two independent networks
  - Incremental circuit turn up to support prelaunch testing

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Assumptions (Cont'd)

- IST traffic will be handled by the NSI; it is not included in the EBnet topology at this time
- Equipment has a 5-year life span; hardware upgrades planned in 5-year increments
- Transition to Asynchronous Transfer Mode (ATM)-based network to begin in fiscal year 1999

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Summaries and Conclusions

- Consolidation of wide-area communications complete
- Version 0 network transition in final phase
- EBnet project on schedule to meet all ESDIS test and operations dates with positive slack
- Recently completed cost rebaseline exercise
- Working to modify ECS contract to include HAIS on EBnet design team
- Planning DAAC site visits
  - Scheduling with DAAC managers
  - Identifying travel funds
- Design review scheduled for November 8, 1995